1976-06

Measurement and evaluation of commercial time-sharing vendors

Callison, Kelly Scott

MEASUREMENT AND EVALUATION OF COMMERCIAL TIME-SHARING VENDORS

Kelly S. Callison

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

MEASUREMENT AND EVALUATION OF
COMMERCIAL TIME-SHARING VENDORS

by

Kelly S. Callison

June 1976

Thesis Advisor: N. F. Schneidewind

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Measurement and Evaluation of Commerical Time-Sharing Vendors		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis; June 1976
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Kelly S. Callison		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		12. REPORT DATE June 1976
		13. NUMBER OF PAGES 46
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Naval Postgraduate School Monterey, California 93940		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Time-sharing
Economic analysis

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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(Page 1) S/N 0102-014-6601 |

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MEASUREMENT AND EVALUATION OF COMMERICAL TIME-SHARING VENDORS

by

Kelly S. Callison
Lieutenant, United States Coast Guard
B.S., United States Coast Guard Academy, 1971

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN COMPUTER SCIENCE

from the

NAVAL POSTGRADUATE SCHOOL

June 1976

ABSTRACT

This is a description of a logical approach to the problem of selecting a commerical time-sharing system for a specific application. Supporting information was gathered from current technical literature and from discussions with both vendors and users. The final result is a blend of the principles of economic analysis and the realities of data processing.

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I. DIMENSIONS OF THE PROBLEM

The process of selecting a commercial time-sharing vendor is very complex. It can entail studying a significant amount of technical detail and making a number of economic approximations. The complexity of the task is greatly compounded by the large number of commerical time-sharing vendors that can be considered.

The sizes of these vendors range from the very large firms, like the General Electric Company with $200 million invested in facilities, to the very small firms, like Applied Data Processing Incorporated with a single computer. In total they offer via batch, remote batch, and interactive modes everything from raw computer power to tailor made application programs. They support remote batch and interactive processing on a regional, national, and international scale [1].

There have been numerous articles written on the subject of time-sharing system selection. In addition Data Pro Research Corporation and Auerbach Publishers Incorporated periodically release guides to time-sharing companies [2,3]. Most of the articles reviewed alerted the reader to specific advantages or disadvantages found in using time-sharing companies [4-7]. The guides are attempts to present a collection of snap-shot views of each company in the market. Neither source of information, articles or guides, presents a global and complete approach to the time-sharing vendor selection problem.

Many studies have been carried out on the related problem of computer selection. E.M. Timmreck's article, "Computer Selection Methodology", summarizes several of the current approaches to this selection problem [8]. It also provides an extensive bibliography on related topics. Studies like Mr. Timmreck's and others have been directed towards the selection of an in-house computer system. (hardware and software to be controlled and operated by the user). Thus these studies are inappropriate when applied to the selection of commerical time-sharing vendors. A time-sharing user is totally dependent on the vendor to provide system security, reliability, etc.

One might ask why the time-sharing vendor has not been more thoroughly studied. The industry has been in existence since 1963 when Adams Associates of Cambridge Massachusetts offered service on a PDP-4 [3]. Lack of concern about the process may be tied to the seemingly short term economic insignificance of selecting a time-sharing vendor. This is especially true when such a decision is compared to the immediate impact on resources of the selection of an in-house computer.

II. SETTING THE STAGE FOR ANALYSIS

The process of economic analysis as described by Charles J. Hitch and Roland N. McKean [9] consists of five elements:

1. The objective definition
2. The system model
3. The alternative solutions
4. The selection criterion
5. The determination of the alternative's costs

In this section the emphasis will be on the first four elements. The fifth element will be discussed in detail in another section.

It is anticipated that this methodology will be applied for each application considered. The application can be one program or many inter-related programs. A system will not require on-line communications with another vendor's system. Multiple vendor systems are beyond the scope of this paper.

A. OBJECTIVE DEFINITION

The cornerstone of a successful economic analysis is defining what is desired from the systems to be studied. In this particular case the question is: what does the prospective user want to achieve by using commerical time-sharing?

It has been observed that success in applying data processing is a consequence of the user's knowledge of his operations. Setting data processing objectives requires an

awareness of present and future information handling needs. Data processing objectives to be viable need to be in line with the future goals or objectives of the company in general [10-12].

To be useful in this study, objectives should be constructed of well defined goals that a system must achieve. Examples include establishing a payroll system with paydays every two weeks, or upgrading a sales forecasting system to receive data from forty offices and to produce a monthly summary by region. Using these well defined goals as guides a system model is produced.

E. SYSTEM MODEL

The model utilized by this study is one of information flow. It is intended that it provide a framework on which to construct the alternatives. Many models will be derived from existing systems. An existing system might be a manual payroll system or inventory system. The model should be independent of any particular method to collect, process, or distribute the information. If a model required that information be collected on punched cards, we would have to treat any alternative that proposed the use of CRT's as unacceptable.

The model has three sections which are input, processing, and output. Inputs have location, time, and volume. In a payroll system these might be where the employee's time on the job is collected, when it is collected, and for how many employees. Processing is the input to output conversion which may require certain calculations and security requirements. In a payroll system these calculations might include figuring gross pay, income

tax deductions, and net pay. Again the calculations and not the method of performing them is stressed. Finally output like input has a location, a time, and a volume. This might be some form of payment to the workers every two weeks.

The model is quite simple conceptually. Its power lies in its ability to isolate that which is relevant, the information flow, so that it can be utilized as a minimum requirement which any system must meet.

C. ALTERNATIVES

Once a system model has been established, vendors can be considered as possible alternatives. It is expected that one or more vendors will directly meet the requirements of the model. These vendors would normally be considered by any methodology.

More interestingly, it is hoped that several alternatives can be constructed out of the set of vendors who do not meet the model requirements directly. It is the premise of this paper that every single vendor is a potential alternative and that only in the worst of cases should one be initially eliminated.

A case is often made for eliminating all vendors who do not offer local dialing in the user's area [2,3,6]. The idea being that communications costs will be much higher without the local dialing feature thus increasing the total cost of using the vendor's system to an unacceptable level. This argument is based on the premise that a vendor who provides local dialing can design his system to take advantage of economies of scale in communications facilities. This argument is not valid if such a vendor

does not obtain the minimum system loading required to achieve such economies [13]. The point is that we should not arbitarily eliminate an otherwise excellent solution. One rule that will be followed in this study is that no major change in hardware or system software will be proposed.

Constructing feasible alternatives involves specifying systems which will meet the requirements of the model. Typically we might have to add a communications system, WATS, Datran, or Telenet, or a commercially available applications package to a time-sharing vendor's system.

D. CRITERION

Finally the analysis should result in our choosing the alternative which "best" achieves our objective. The problem of course is in defining "best". In many cases "best" is taken to mean that system which satisfies a given objective for the least cost. Dollars provide a common unit of measure that can be used to compare the various alternatives [8].

In certain cases there may be constraints which over-ride or limit the use of the least cost criterion. Time is often such a constraint. The requirement that the resulting system be running tommorrow may preclude the use of a system which is less costly, but not available for a month.

Constraints are often unavoidable. They can drastically reduce the number of alternatives to be considered. As such they should be screened carefully for validity. Will the constraint be valid tomorrow?

In economic analysis there is another approach to achieving the objective. This approach requires cost to be fixed at some level and an alternative is selected which maximizes gain. This approach may be used where there are budget constraints [9]. The difficulty in using this approach is in quantifying gain.

III. ESTABLISHING ALTERNATIVE COSTS

Having formed a set of alternatives, the next step is to establish a cost for each of them. In this section a general discussion of cost considerations applicable to most forms of economic analysis will be presented. This will be followed by a discussion of cost considerations peculiar to commerical time-sharing applications.

A. GENERAL CONSIDERATIONS

The cost of an alternative consists of two parts, direct costs and indirect costs [14]. Direct costs are borne solely by the alternative under consideration while indirect costs are shared with other systems. In a remote job entry system the remote terminal is a direct cost. Janitorial service for the office in which the terminal is located is probably shared by other office tenants and is an indirect cost to the remote job entry system. Indirect costs are usually difficult to measure and must often be estimated. If they are equal for all alternatives, they do not need to be included.

Costs are normally sought for the life of the application. One objective may have a life span of six months, another may have an apparently infinite life span. The standard life span used by government agencies is five years and that will be utilized here [9].

Discounting should be applied to the alternative's costs. The use of discounting is based on the simple notion that any rational person would, other things being equal, prefer to have one dollar today then one dollar at some future date. The current discount rate used by the U.S. Government is six percent. The discount rate should be increased above the standard rate if there is a high probability that the project will not be taken through to completion. This forces projects to be taken at a slower pace. Less money will have been invested if the project is terminated [9,14].

Frequently alternatives will make use of resources whose costs have already been paid. The cost of these resources, called sunk costs, are never added into the alternative's costs. A remote job entry terminal already owned should not be considered in the total cost of an alternative which utilizes it. It should be noted that the maintenance costs of such equipment may be a direct or indirect cost to be considered [9,14].

Resources that will no longer be required because a particular alternative is selected, or those that will exist at the end of a system's life span, must be appraised. The value of these resources, salvage value, should be estimated and subtracted from an alternative's total cost. Again refering to the installation of a remote job entry terminal, if a piece of EAM equipment is to be replaced and sold, its resale value should be subtracted from the remote job entry system's cost. If it is expected that when the project is completed the terminal will have a resale value, this also can be subtracted from the alternative's cost [9,14].

B. SPECIFIC CONSIDERATIONS

1. Communication Costs

Communications charges include any cost incurred in the collection, transmission, reception, and distribution of information. The modes of processing and their communication requirements considered are batch, remote batch, and interactive. For the evaluation of collection and distribution costs these modes will be discussed together.

There are three basic cost elements in the collection and distribution function. These cost elements are personnel, equipment, and forms or supplies. A direct way to calculate these costs is to first examine the forms or supplies required. This can be determined directly from the model. Knowing that a certain number of customer's purchase orders per period will be converted to punched cards, it is possible to find the number of keypunches, verifiers, and operators needed. This same logic can also be applied to the distribution of information. From the model it is possible to estimate the number of output lines to be printed, the number of computer output microfilm slides to be produced, etc..

The transmission and reception function to be evaluated in batch systems is simply pick-up and delivery costs. Many vendors who offer batch processing also provide free pick-up and delivery services. These services are provided to limited areas and sometimes on a limited schedule. A user outside this delivery area or with a

special schedule will incur additonal costs. The user can also consider the U.S. Postal Service, private delivery services, or the use of in-house personnel.

Interactive and remote batch communication systems can vary in complexity with many trade-offs made in designing them. The details of such a design process should be avoided in this analysis. The user should concern himself with estimates for the cost of the terminal, modem, and communications line. Both Data Pro Research Corporation and Auerbach Publishers Incorporated provide price lists that are useful for this purpose. Terminal purchase prices vary considerably from less than a thousand dollars for a basic interactive terminal to over fifty thousand dollars for a remote job entry terminal. Modem prices can be estimated at $0.50 per bps in the 300 to 4800 bps range [15]. Communications lines can be provided by a variety of carriers, conventional, specialized, satellite, and value added [16].

Since the results of this last section on communication's cost estimation is in terms of gross figures, care should be exercised in using them. These costs ignore many technical considerations that should be reviewed prior to making a final selection. Reliability and support will be discussed at a later point.

2. Hardware Costs

Since one of the assumptions was that no hardware or system's software changes would be considered, most hardware requirements must be considered as constraints. Parameters such as the maximum number of simultaneous users, maximum program size, maximum number of disk packs or tapes simultaneously mounted, could be used to eliminate a vendor.

As constraints, such parameters will not be considered in the total system cost. This leaves only the actual processing cost and storage cost to be considered in this section.

a. Processing Costs

(1) Cost Algorithms. When this study was first undertaken a considerable amount of time was spent investigating the various cost allocation algorithms used by commerical time-sharing vendors. These algorithms are used to bill for central processing unit usage, main memory residency, input and output interrupts, channel usage--as well as the use of peripheral devices. They are resource allocation schemes through which the vendor recovers his costs and makes a profit [17-21].

The usefulness of such algorithms in estimating processing costs is limited. For instance some vendors consider CPU time as that time during which a user's program is being executed, while others include swapping time [4]. If the necessary parameters are available from other sources, such as present users with a similar application, the cost algorithm can be used to give a rough estimate of processing costs.

The main value of such algorithms is providing information once an application is operational. It allows the user to insure that he is being properly charged every month and to spot a problem area if costs begin to rise.

(2) Transaction Pricing. As time-sharing firms continue to provide an increased number of specialized application packages, transaction pricing should become more

prevalent [22]. Rather then billing the user for resources used, CPU seconds etc., the vendor bills for a unit of information entered or received. This unit could be an order entered in an order processing system, or a paycheck issued in a payroll system. The vendor has estimated from historical data the resources required for a particular application and translated this into a transaction price. This method simplifies cost estimation.

As the user becomes more sophisticated, familiar with the use of the system, he may require services not previously priced in terms of transactions. This may require negotiation of a new transaction unit and price or the use of the vendor's cost algorithm.

(3) Benchmarks. Benchmarks are existing programs typical of the user's anticipated workload which are run on the system under evaluation [23]. The typical application programs are the best means of obtaining the processing cost of a system [8]. If a specific application package is to be utilized, the best way to estimate its processing costs is to run the system with actual test data. If a user supplied program is to be used, then it should be re-coded as necessary and run on the prospective vendor's machine.

There are several problems in using this technique to establish processing costs. In the testing of a vendor's application package a considerable amount of effort may be required to provided appropriate test data that will reflect the user's workload. If a user's program is to be tested, there may be a significant cost involved in converting it to run on a vendor's system. The costs involved with using a benchmark test do not exclude it, but rather point to the fact that it is best applied to a restricted number of choices.

(4) Synthetic Programing. Synthetic programing uses a set of standard modules to represent a user's workload. The standard modules allow the program to be transferred from one machine to another. It permits the user to test the system's sensitivity to changes in workload. The major disadvantage is that it is difficult to portray the actual workload. Despite this disadvantage synthetic programing appears to be a viable way to establish processing costs [23].

A factor which effects both the use of synthetic programing and benchmarks is system loading. System loading can drastically effect cost figures. As the system becomes saturated, the operating system's overhead becomes a significant factor [7,24,25]. To achieve an accurate test using these two techniques, the system should be exercised under conditions similar to expected operational conditions. Consideration should be given to the time of day, the number and location of data entry points, and the sequences of operation.

b. Storage Costs

Storage costs are estimated using the vendor's price list. It was found helpful to convert all prices to a common 10,000 characters/day price. This ignores several important factors such as sector sizes and minimum billing periods. These considerations should be investigated if the final choice must be made between several vendors with approximately equal system costs.

3. Software Costs

The three types of software considered are application packages, user provided programs, and user produced programs. Most time-sharing vendors provide application packages at an added cost to the user. Benchmarks provide an evaluation of these packages within the context of the entire system's performance and cost. Transaction pricing includes such software costs.

The installation and use of an application package from an outside software company will require close cooperation with the time-sharing vendor. There are many hardeware and software requirements that must be examined before such an installation can be considered feasible. The actual cost of the package, while open to negotiation, can be established [2].

Estimating the processing cost of an outside software company's package will be difficult, unless the software company will allow a test on the time-sharing vendor's system. The user will have to settle for a gross estimate of the processing costs. Using present package user's experiences, the time-sharing vendor's knowledge of his system and the cost allocation algorithm discussed in the hardware section, the user should be able to produce a range of possible costs. Other costs, support, training, etc. will be discussed in later sections.

User provided programs are often installed on commerical time-sharing systems because in-house systems are saturated or in a transition state. This type of service provides a substancial portion of commerical time-sharing's revenue [1]. The user is either seeking maximum

compatibility with his existing system so that software conversion is minimal or he is converting his software to run on another system. Processing costs will be established by bench mark tests. Other features to consider are conversion aids such as tape conversion or code conversion programs.

The final software situation to be considered is a user developing his own programs on a commerical time-sharing system. The user must estimate the programing and debugging time based on the language used, the interactive editor if required, and other factors. For instance, one study found that it takes about three times as long to program and debug a problem using FORTRAN or PL/1 as it does using APL. Balance this with the fact that the interpreted execution of the APL program costs a factor of ten to a hundred more then the execution time to obtain a solution to the same problem using a compiled program [24]. Gold [26] found that if the system was also to be used for the problem formulation phase of program development, interactive user's required five times the computer time needed by batch, or remote batch users. On the other hand he found that the total man time required was less with interactive programming.

Krauss [27] presents a programming time estimating method that can be useful in establishing a range of times. Using the projected program size, complexity, types of I/O devices, programming language, and programer skill he arrives at programming time in man-days.

4. Support Costs

The remaining costs to be considered have been grouped in the category of support. This includes training, documentation, service and reliability, and security. Of the four sections discussed, support costs require the most subjective approach. They can be extremely difficult to estimate and are often subject to substancial error [8]. The costs discussed are applicable to any supplier.

a. Training Costs

Training will be required through-out the life of an application. First there is the heavy emphasis on training prior to and during the start-up of an application. This will be followed with periodic training requirements as the user experiences personnel turn-over.

It is important to investigate what the training fee quoted by the vendor includes. If it applies only at specific training facilities a user would have to provide transportation and lodging for the students. If training is provided at the user's site transportation and lodging for the instructors may be an additional cost.

As with many of the costs to be discussed in the support section the user must depend heavily on the vendor's present and past customers in evaluating training support. If it is found that the standard training packages offered are incomplete, costs must be established for additional training. All training does not have to be supplied by the time-sharing vendor. Background courses which are not machine dependent can be obtained from several sources.

b. Documentation Costs

The type and amount of documentation a user will require varies considerably based on the application and the user's familiarity with data processing in general. The cost of the documentation is a straight forward calculation. Availability and source location should be considered since they affect delivery time.

Costs associated with incomplete or inaccurate documentation are not easy to calculate. Incomplete documentation may keep the user from realizing the system's total potential. Inaccurate documentation can cause delays in using the system, personnel may be idled, customers billed late, etc. Again a vendor's present and past customers can provide an insight into this area.

For local users, problems in the documentation can be overcome by talking to the staff at the vendor's computer center. This may mean a short walk or drive. The remote user must depend on the telephone or the mail which puts him at a distinct disadvantage with faulty documentation.

Marshall Abrams [28] has suggested several possible ways to help over come documentation problems faced by remote users: A daily "message of the day" which is presented when the user logs on the system. A file of previous messages can be kept for the information of the infrequent user. A vendor can provide indexed online documentaion. Finally an online "graffiti" file can be maintained for informal comments on the system.

It is possible to have more documentation then

necessary. The user should determine which documentation is necessary as opposed to merely available. Someone using an application package may not need documentation on the system's FORTRAN compiler.

c. Service And Reliability Costs

The cost associated with service and reliability is a function of the number of system failures, hardware and software, over the application's life, the average time required to correct a failure, and the user's cost while the system is down. This cost can be significant because reliability has been a major problem for commerical time-sharing vendors and service arrangements can be quite complex [7]. A user could potentially have to deal with a terminal manufacturer, modem manufacturer, communications carrier, time-sharing vendor, and application software company all pointing fingers at each other when there is a problem.

Present and past customers should be queried about a vendor's reliability. Factors such as the availability of back-up computers, communications equipment, and power supplies should also be investigated in attempting to establish an estimate of the number of failures to expect over the application's life.

If a system failure occurs, many time-sharing vendors will replace or regenerate lost or damaged data from the user's supporting material if such errors were caused by the vendor, its equipment or its employees. Some will credit the user's account for system use invalidated by such errors. Most if not all will not assume any other liabilities in this area.

The time required to fix a system failure depends on the seriousness of the failure, the availability of service personnel, and the availability of replacement or alternate parts. It will be assumed that parts will always be available unless present or past users indicate this to be a problem. Another simplification is to assume that all vendors suffer similar failures over the application's life. Both appear to be reasonable assumptions which will allow the user to consider only the availability of service personnel.

Service personnel will be considered in two groups. One group is responsible for all hardware failures; these are the technicians. The other group is responsible for software problems; these are the programmers. The major reason for discussing service personnel as two groups is because technicians usually must be available at the site of the failure while programmers need not be.

In estimating the time it takes a technician to repair a piece of equipment a major consideration will be how long it takes to arrive at the site. This can be done by figuring out the distances between service shops and all the equipment that must be maintained: terminals, modems, switching centers, and computer centers. Using the driving or flying time one can construct a reasonable estimate for response time. If service is not included in the use of the equipment it must be added to the system cost. Those vendors offering extensive diagnostics should be given a time credit since their technicians will probably arrive with the right part to fix the problem.

If programmers are not readily available some means of communicating with them should be established [28]. The user should check into the hours that consultants are available and if they can be reached via a WATS, ENTERPRISE,

or leased line. An important factor is also whether the vendor markets and supports an application or only markets it. In the latter case the user may have to make his own arrangements for programing support.

d. Security Costs

Currently no protection sub-system of any major multi-user computer system is known to have withstood serious attempts at circumvention. It is not even currently possible to provide a meaningful guarantee that a system actually provides the controlled protection which the designer claims [29-31]. This security problem is compounded in the case of commerical time-sharing vendors because the user has no control over the physical plant or those personnel who operate it. Without question the trusted insider is the greatest threat to any computer system [29].

The user must carefully evaluate the security requirements of his application [33]. The above statement on multi-user systems does not imply that there is no security available on such systems only that it is not absolute. Increased security implies added expenses. Most security techniques incur added system overhead the user must pay for. This overhead will be accounted for if the system is tested with a benchmark or synthetic programing. Other methods for estimating the cost can assume a 10-15 percent increase in overhead [32].

Until such time as there exists a method to certify a system's security, the user must accept the vendor's claim. This claim can be backed-up by the vendor bonding his services. A user might estimate the cost of a security violation and request a bond in this range. This

will increase the system's cost. Besides this the user has the obligation to insure that his in-house security is equal to or greater then that which he imposes on the vendor.

Other security costs include the cost to add, delete, or modify users passwords and security profile.

e. Miscellaneous Costs

A difficult factor to assess is the time-sharing vendor's future. This has two aspects, the probability that he will not stay in business, and that he will not continue to support a user's application. Using the cost of converting to another vendor's system or the cost of outside support, this factor can be evaluated (probability*cost).

Many vendors offer volume discounts based on the size of the user's monthly bill. These discounts should be reviewed carefully because they often apply to specific items, CPU usage etc., rather than to the whole bill. They should be applied to the analysis where applicable.

The vendor should provide the user an estimate of the session's cost at log-off time. They should also provide a detailed monthly bill by account numbers. Both of these techniques have been identified as ways to prevent uncontrolled cost escalation [5].

IV. EXAMPLE APPLICATION

The following example is hypothetical, but should illustrate many of the points discussed in the paper. To improve its search and rescue effort, the Coast Guard has determined that it requires more-up-date information in its Rescue Coordination Centers. This problem has been carefully studied by upper management and a preliminary design has been established. (Paragraph headers used correspond to the paragraph headers found in the body of the thesis)

II.A. Objective Definition:

Improve the search and rescue effort by providing to each District Rescue Coordination Center (RCC) on demand, timely search plans, on-scene weather information, and drift plots. Timely, based on a study of average helicopter on-scene arrival times, is defined as being within ten minutes of the request. Such information should be available twenty-four hours a day, seven days a week.

II.B. System Model: (Based on historical data)

Input:

Districts: (all 12 combined)

Searches	3,000/year+8%/year
Modifications	1,000/year+6%/year
Requirements	
Drift Plots	3/search
Weather Information	2/search
Search Plans	6/search

AMVER:

Weather Updates	2,200/year
System Maintenance	52 hours/year

Processing:

Combining time, weather and search unit to produce output

Outputs:

Districts:

Drift Plots	3/search
Weather Information	2/search
Search Plans	6/search

AMVER:

Maintenance Reports	15/year
Collected Statistics	12/year

II.C. Alternatives:

In this example only two alternatives will be considered. Normally the user should consider as many as time permits.

The first alternative combines:

1. A San Francisco based time-sharing vendor which supports interactive processing via a 2400 baud data communications network. Local dialing is provided at all District offices except Honolulu, Hawaii and Juneau, Alaska.
2. Data communications to Honolulu and Juneau thorough multiplexing on existing district lines.
3. Purchased buffered 2400 baud terminals.
4. Leased 2400 baud modems.
5. Leased 4800 baud multiplexers for Honolulu and Juneau.
6. An existing Coast Guard program which will carry out the necessary processing. The program is written in ANSI FORTRAN.

The second alternative combines:

1. A New York based time-sharing vendor which supports interactive processing via a 300 baud data communications network. Local dialing is provided at all District offices.
2. Purchased 300 baud terminals.
3. Purchased 300 baud modems.
4. An existing Coast Guard program which will carry out the necessary processing. The program is written in ANSI FORTRAN.

II.D. Criterion:

The selection criterion used will be least cost.

III.B. Specific Costs First Alternative:

III.B.1. Communication Costs:

Juneau-San Francisco	
Transmission Line(1)	$ 100/month
4800 baud Modem(2)	$ 123/month
Multiplexer(2)	$ 100/month
Terminal(1)	$ 2,000 purchase
5 yr Salvage Value	$ 500
Installation	$ 300
Local Charges	$ 50/month
Honolulu-San Francisco	
Transmission Line(1)	$ 400/month
4800 baud Modem(2)	$ 123/month
Multiplexer(2)	$ 100/month
Terminal(1)	$ 2,000 purchase
5 yr Salvage Value	$ 500
Installation	$ 300
Local Charges	$ 50/month
Remaining Districts(10)	
2400 baud Modem(8)	$ 504/month
2400 baud Modem(2)	NO COST
5 yr Salvage Value	$ 600
Terminal(10)	$20,000 purchase
5 yr Salvage Value	$ 5,000
AMVER	
2400 baud Modem(1)	$ 63/month
Terminal w/ Tape Unit(1)	$ 3,500 purchase
5 yr Salvage Value	$ 875

Existing lines are leased 9600 baud lines presently used at 2400 baud. ($1,000/month Juneau-San Francisco, $2,000/month honolulu-San Francisco) The alternative's transmission line costs for Juneau and Honolulu are based on expected usage. (1/10 and 2/10 respectively) Modem and multiplexer costs are based on the dedication of one of two ports to the application. Two modems owned by the Coast

Guard are released by this alternative, from Honolulu and Juneau, for use by another District in the system.

III.B.2. Hardware Costs:

Processing Costs: (established with benchmark)

Prime-Time (0800-1700 PST)		
Operational Session	$	90/session
Maintenance	$	15/hour
Weather Update	$	10/update
Non-Prime-Time		
Operational Session	$	65/session
Weather Update	$	6/update

Storage Costs:

On-line (400,000 characters)	$	128/month
Off-line (10 tapes)	$	30/month

It has been estimated that thirty (30) percent of the operational use will be during prime-time hours. All session costs are based on the production of three drift plots, two weather plots, and six search plans which is considered average for a search and rescue mission. Storage costs are based on one complete day's weather and the six previous day's weather summaries.

III.B.3. Software Costs:

In this particular case there are no software conversion costs because the vendor supports the ANSI FORTAN compiler used by the Coast Guard to develop the program. All program development costs can be considered sunk costs in this case. Had this not been the case software conversion costs would have to be estimated. Benchmark tests would have been put-off until the field of possible alternatives had been reduced.

III.B.4. Support Costs:

Training Costs:	
Maintenance Programmer	$ 600/year
RCC Controllers	
System Start-up	$ 3,919
Operational	$ 50/person
Documentation Costs:	
Maintenance	NO COST
Application	$ 600/200 copies
Service And Reliability Costs:	
Down Time Cost	$ 500/hour
Down Time	10 hours/year
Service Contracts	
Terminals	$ 50/month
Multiplexers	$ 40/month
Maintenance Programmer	$ 455/year
Federal Telephone Service	$ 20/month
Security Costs	NOT APPLICABLE

The maintenance programmer training cost consists of sending one programmer to the vendor's free two day system's school once a year in San Francisco. Cost includes airfare and the programmer's wages for three days. (GS-11 $70/day plus per diem) The RCC Controller training cost is broken down into two categories. System start-up includes transporting one controller from each District to a training session in New York. After the system is operational all controllers will receive instruction on the system while attending the regular search and rescue school.

Documentation about the vendor's system is free for use by the maintenance programmer. The Coast Guard will publish a user's guide which contains all necessary information about the search and rescue program and the vendor's system. Changes will be issued by Commandant's Notices. Costs for four such changes are included in the documentation costs

for the application.

Management has determined that the cost to the Coast Guard is $500/hour when the system is down and a SAR case is in progress. This is based on the cost of having a unit at the scene and the time required to generate a search plan manually verses automatically. Often this cost is established very subjectively. The effect on the analysis is to raise or lower the importance of service and reliability in relation to all other factors. Using present and past user's experiences it has been estimated that the system will be down ten hours of search time per year.

System programmers are available twenty-four (24) hours a day at the vendor's computer center. They can be reached via a toll free number. Maintenance programmers are available at the AMVER Center 0800-1630 EST or within ten minutes at other times. It is expected that maintenance programmers will not spend much time on the application.

III. Summary Of Alternative's Cost

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Communications					
Juneau	6,776	4,476	4,476	4,476	3,976
Honolulu	10,376	8,076	8,076	8,076	7,576
Other Districts	26,048	6,048	6,048	6,048	448
AMVER	4,256	756	756	756	-119
Hardware					
Prime-Time					
Operational	81,000	87,480	94,478	102,036	110,160
Maintenance	780	780	780	780	780
Weather-Update	7,200	7,200	7,200	7,200	7,200
Non-Prime-Time					
Operational	136,500	147,420	159,213	171,925	185,705
Weather-Update	8,760	8,760	8,760	8,760	8,760
Storage					
On-Line	1,536	1,536	1,536	1,536	1,536
Off-Line	360	360	360	360	360
Software	0	0	0	0	0
Support					
Training					
Maintenance	600	600	600	600	600
Users	4,919	1,000	1,000	1,000	1,000
Documentation					
Maintenance	0	0	0	0	0
Users	600	0	600	0	0
Service and Reliability	6,775	6,775	6,775	6,775	6,775
Security	0	0	0	0	0
TOTAL	296,486	281,267	300,658	320,328	334,757
Present Value(6%)	296,486	265,339	267,584	268,953	265,159

TOTAL SYSTEM COST IS $1,363,521

III.B. Specific Costs Second Alternative:

III.B.1. Communication Costs:

Districts (12)		
300 baud Modem (12)	$ 1,800	purchase
5 yr Salvage Value	$ 450	
Terminal (12)	$14,400	purchase
5 yr Salvage Value	$ 3,600	
AMVER		
300 baud Modem (1)	$ 150	purchase
5 yr Salvage Value	$ 38	
Terminal w/ Tape Unit (1)	$ 3,000	purchase
5 yr Salvage Value	$ 750	

III.B.2. Hardware Costs:

Processing Costs: (established with benchmark)	
Prime-Time (0800-1700 EST)	
Operational Session	$ 96/session
Maintenance	$ 20/hour
Weather Update	$ 11/update
Non-Prime-Time	
Operational Session	$ 60/session
Weather Update	$ 4/update
Storage Costs:	
On-line (400,000 characters)	$ 300/month
Off-line (10 tapes)	NO COST

It has been estimated that forty (40) percent of the operational use will be during prime-time hours. All session costs are based on the production of three drift plots, two weather plots, and six search plans which is considered average for a search and rescue mission. Storage costs are based on one complete day's weather and the six previous day's weather summaries.

III.B.3. Software Costs:

Software considerations remain unchanged.

III.B.4. Support Costs:

Training Costs:	
Maintenance Programmer	$ 140/year
RCC Controllers	
System Start-up	$ 3,919
Operational	$ 50/person
Documentation Costs:	
Maintenance	$ 50/year
Application	$ 600/200 copies
Service And Reliability Costs:	
Down Time Cost	$ 500/hour
Down Time	25 hours/year
Service Contracts	
Terminals	$ 50/month
Maintenance Programmer	$ 455/year
Federal Telephone Service	$ 20/month
Security Costs	NOT APPLICABLE

The maintenance programmer training cost consists of sending one programmer to the vendor's free two day system's school once a year in New York. Cost includes the programmer's wages for two days. (GS-11 $70/day) The RCC Controller training is the same as in the first alternative.

Documentation about the vendor's system is not free. The Coast Guard will handle the documentation of the system as specified in the first alternative.

System programmers are available twenty-four (24) hours a day at the vendor's computer center. Maintenance programmers are available at the AMVER Center 0800-1630 EST or within ten minutes at other times. It is expected that maintenance programmers will not spend much time on the application.

III. Summary Of Alternative's Cost

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Communications					
Districts	16,200	0	0	0	-4,050
AMVER	3,150	0	0	0	-788
Hardware					
Prime-Time					
Operational	115,200	124,416	134,400	145,152	156,672
Maintenance	1,040	1,040	1,040	1,040	1,040
Weather-Update	8,030	8,030	8,030	8,030	8,030
Non-Prime-Time					
Operational	108,000	116,640	125,940	136,020	146,940
Weather-Update	16,060	16,060	16,060	16,060	16,060
Storage					
On-Line	3,600	3,600	3,600	3,600	3,600
Off-Line	0	0	0	0	0
Software	0	0	0	0	0
Support					
Training					
Maintenance	140	140	140	140	140
Users	4,919	1,000	1,000	1,000	1,000
Documentation					
Maintenance	50	50	50	50	50
Users	600	0	600	0	0
Service and Reliability	13,795	13,795	13,795	13,795	13,795
Security	0	0	0	0	0
TOTAL	290,784	284,771	300,915	324,837	342,489
Present Value (6%)	290,784	267,684	267,811	272,736	271,282

TOTAL SYSTEM COST IS $1,370,297

The total costs of the two alternatives are close enough to warrent a further investigation of both systems. In the first alternative the user might want to look very carefully at the communication's interface for Honolulu and Juneau into the vendor's system. With both systems the vendors may be prepared to offer substancial discounts to attract the user. In any application of this methodology a further investigation involves the refinement of costs within the outline provided until a clear prospect stands out.

V. CONCLUSION

The application of the principles of economic analysis, as presented here, is a viable approach to the problem of selecting a commerical time-sharing vendor. It is an approach that can be utilized by users of varying data processing sophistication. The power of the approach lies in its ability to guide the user from a global view of the problem to an optimum solution. Such guidance, essential for the unsophisticated user, was found to be lacking in other approaches considered.

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Thesis 166039
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c.1 Measurement and evaluation of commercial time-sharing vendors.